QA 111
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Mathematical Short Cuts

On the Line of Least Resistance.

Addition by Subtraction

—AND—

Subtraction by Addition

Lightning Calculation

—BY—

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ROCKPORT, INDIANA.

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QA 111
S63

TO THE

THINKING TEACHER OR STUDENT EVERYWHERE.

The bequest of
Daniel Murray,
Washington, D. C.
1925.

Preface.

"Why tug along in a tow-boat, when you can travel by lightning express just as cheap?"

In this age of rapid transit and close competition, success comes to him who is able to accomplish most at the least expense.

All arithmetical operations employed in mercantile business must be performed with absolute accuracy and great rapidity. If we would have absolute accuracy and rapidity we must have a thorough mastery of the elementary work in numbers, and move along the line of least resistance.

This mastery can only be acquired by thoughtful and constant drill upon the elementary facts of number relations. Every teacher should enable his pupils to be rapid and accurate in all computations. He should empower him to move along the line of least resistance.

"Short cuts in arithmetic saves time, decreases the mental effort, insures greater accuracy, and promotes alertness," says Prof. R. J. Aley of Bloomington, Ind.

The Arabic method of computation is based upon the scale of 10, and the nearer the operation is performed to 10 or by 10 or its multiple, the least will be resistance and easier the result can be obtained.

Whether computing in the tens, hundreds or thousands, etc., the ten and its relation to the numbers which compose it, must be kept in mind.

Thus in adding and subtracting in the teens, hundreds, thousands, millions, the learner need not think higher than ten and its relations to the numbers which compose it. For higher numbers are only the parts of ten added to ten or to the multiple of ten.

It is a fundamental principle of right teaching, that the pupil should be conscious of the relations of the facts under consideration and that this consciousness lives longer by visual conception: therefore great emphasis should be put upon visual conception in number work.

The man or pupil that can do the most accurate work in the allotted time is the person that demands the best positions.

This little volume will be worth its weight in gold to the student or teacher who wishes to be quick and accurate in computation.

The student will find that Mathematical Short Cuts will go hand in hand with every department of arithmetical work, and will start the learner out upon a mathematical research.

Wishing the learner and teacher an increase of speed in all his computations,

I remain yours sincerely,

THE AUTHOR.

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Addition by Subtraction.

RULE 1.

When adding by 9 take 1 from the number given and increase it by 10: thus 9 and 8 equal 1 from 8 plus 10 which is 17.

Continue an oral exercise to 100. Let the answers follow immediately the question. Thus 9 and 58=67; 9 and 89=98, etc.

When adding large numbers, proceed as follows: Subtract from 8, write 7, bring down 7, 6, 3, 2 and 18 without counting. See that this is true with 9 in all addition when 9 is to be taken from a number that one has been borrowed. Practice makes perfect.

823678
999999
1823677

RULE 2.

When adding by 8 take 2 from the given number and increase it by 10: thus 9 and 8 equal 2 from 9 plus 10 which is 17.

923654
888888
1812542

When adding larger numbers, proceed as follows: Subtract 2 from 4 and write 2; take 1 from 5, 6,3, 2, 9 and write 4, 5, 2, 1 and 18.

RULE 3.

When adding by 7, take 3 from the given number and increase it by 10. Thus: 7 and 38 equal 3 from 38 plus 10 which is 45

984568
777777
1762345

When adding large numbers proceed as follows: Take 3 from 8, write 5; take 2 from 6, 5, 4, 8 and 9, write 4, 3, 2, 6 and 17.

When adding by the 6, take 4 from the given number and increase it by 10. Thus: 6 and 37 equal 4 from 37 plus 10 which is 43.

9846858
6666666
16513524

When adding large numbers, proceed as follows: Take 4 from 8, write 4; take 3 from 5, 8, 6, 4, 8, 9 and write 2, 5, 3, 1, 5 and 16.

Thus in adding 5 subtract 5, in adding 4 subtract 6 and so on.

8236724
9899997
18136721

Adding by subtraction is more rapidly computed than adding by the old carrying method. Note the following: Take 3 from 4, write 1; bring down 2, 7, 6, 3; take 1 from 8, write 1, write 18.

A little effort on your part, dear learner, will enable you to add accurately, faster than you write the answer.

The learner is now ready for the addition of longer columns. His former work has so strengthened him that greater aggregation of numbers will be comparatively easy.

Adding by Multiplication and Addition.

8799
7999
3627
4372
2299
8999
5345
41440

5 nines plus 5=50: write 0, carry 5; 6 nines=54, write 4, carry 5; 4 nines =36, plus 7= 44, write 4, carry 4; 5 eights plus 1 = 41, write 41 as the last result.

Adding by Putting Down the Sums Thus:

84682
34234 19
67823 26
27234 29
21672 27
12324 24
247969

Put the sum of each column by the lines as shown; begin at the top next to the line and write all the figures and the last sum.

To Add Two Columns at Once.

4234
3233
4242
1210
4232
17151

Think together two columns thus: 32, 42 and 10 are 84; 84 and 67 are 151; write 51 and carry 1; 42, 12 and 42 are 96; 96 and 74 are 170; 170 plus 1 = 171; write as a final result 171.

By constant practice in small numbers this method of adding will become less difficult.

Proof of Addition by Unitation.

4236=15
6424=16
2352=12
3423=12
55=10
16435=19=10 } Proof.

Add the numbers across, add their sums; add the result across; add the sum of the problem across; also add the result across. If it equals the trial numbers, it is correct.

Subtraction by Addition.

RULE 1.

When subtracting 9 add 1 to the given number or minuend and diminish it by 10. Thus: 9 from 27 equals 1 plus 27 minus 10, which is 19.

Drill to 100, orally.

4234678
1999999
2234679

When subtracting large numbers proceed as follows: Add 1 to 8, write 9; bring down 7, 6, 4, 3, 2 and 2.

RULE 2.

When subtracting by 8 add 2 to the minuend and diminish it by 10. Thus: 37 minus 8 equals 2 plus 37 minus 10, which is 29.

92362
78888
13474

Proceed as follows with large numbers; Add 2 to 2, write 4; add 1 to 6, 3, 2, write 7, 4 and 3; 7 from 8 leaves 1, write 1.

RULE 3.

When subtracting by 7 add 3 to the minuend and diminish it by 10. Thus: 33—7=33+3—10=26.

832464
687777
154687

When subtracting large numbers proceed as follows: Add 3 to 4, write 7; add 2 to 6, 4, 2, 3, bring down 8, 6, 4 and 5, write 1.

RULE 4.

When subtracting by 6 add 4 to the minuend and diminish it by 10. Thus: 83—6=83+4—10=77.

842342
466666
375676

When subtracting large numbers proceed as follows: Add 4 to 2, write 6; add 3 to 4, 3 and 4; bring down 7, 6, 5, 7 and 3.

Proof of Subtraction by Unitation.

9236=20=2
4698=27=9+2=11=2. Proof.
4538=20=2

Add the terms across; add the unitate of the subtrahend to the remainder. If it is the same as the minuend the work is correct.

Short cuts in multiplication when the multiplier is an aliquot part of a hundred or a thousand. Commit to memory the following table of parts:

25 $=\frac{1}{4}$ of 100	$8\frac{1}{3}$=1-12 of 100
50 $=\frac{1}{2}$ of 100	$16\frac{2}{3}$=1-6 of 100
$33\frac{1}{3}=\frac{1}{3}$ of 100	$6\frac{2}{3}$=1-15 of 100
75 $=\frac{3}{4}$ of 100	$66\frac{2}{3}=\frac{2}{3}$ of 100
$12\frac{1}{2}=\frac{1}{8}$ of 100	$37\frac{1}{2}=\frac{3}{8}$ of 100

To multiply by any of the above numbers, add 2 ciphers to the multiplicand and divide by the number of parts it is of 100. Thus: $16\frac{2}{3}\times246=2460\div6\times100=4100$.

The table of the aliquot parts of 1000:

$166\frac{1}{2}$=1-6 of 1000	125 $=\frac{1}{8}$ of 1000
250 $=\frac{1}{4}$ of 1000	375 $=\frac{3}{8}$ of 1000
750 $=\frac{3}{4}$ of 1000	625 $=\frac{5}{8}$ of 1000
500 $=\frac{1}{2}$ of 1000	$833\frac{1}{3}$=5-6 of 1000
$333\frac{1}{3}=\frac{1}{3}$ of 1000	875 $=\frac{7}{8}$ of 1000
$666\frac{2}{3}=\frac{2}{3}$ of 1000	

To multiply by the aliquot parts of 1000, add three ciphers to the multiplicand and divide by the number of parts it is of 1000. Thus: $125\times248=248000\div\frac{1}{8}=31000$.

To multiply by 2 figures when the multiplier does not exceed 20, multiply by the unit figure only, and carry the figures of the multiplicand respectively; bring down the last figure of the multiplicand on the left; add if any to carry.

$$\begin{array}{r} 12342 \\ \underline{\quad\;\; 15} \\ 185130 \end{array}$$

Thus in the above: $5\times2=10$, write 0, carry 1; $5\times4=20$; $20+1+2=23$, write 3 carry 2; $5\times3=15$; $15+2+4=21$, write 2, carry 1; $5\times2=10$; $10+2+3=15$, write 5 and carry 1; $5\times1=5$, $5+1+2=8$, write 8 and bring down 1.

To multiply by 100, 1000, etc., annex to the 2 as many ciphers contained in the multiplier. Thus: $100\times989=98900$; $1000\times789=789000$.

To multiply by 9,, 99, 999, etc., annex a cipher for each 9 to the multiplicand and subtract the multiplicand from it. Thus: $999\times265=265000-265=264735$.

To multiply by 49 add 2 ciphers to the multiplicand subtract the multiplicand from half of the result. Thus $49\times2482=248200\div2-2482=121618$.

To multiply by 19 annex 2 ciphers to the multiplicand and divide by 5, and subtract the multiplicand from the result. Thus: $19\times255=25500\div5=5100$; $5100-255=4845$ product.

To multiply by 101, 1001, etc., annex 2 ciphers to the multiplicand and add to this the multiplicand. Thus: $246\times101=24600+246=24846$ product.

To multiply by 11 write the first figure of the multiplicand as the first figure of the product, add the first and second, the second and third, and so on respectively, carry if need be; then write the last left hand figure as the last in the product. Thus: $11\times254=2794$; write 4, add 4 and 5: write 9, add 5 and 2; write 7 and write 2.

To multiply by 211, 411, etc., multiply by the rule of 11 and add the products of the hundreds to it. Thus: $211\times223=2453+44600=47053$

To multiply 2 like numbers ending in 5, write 25 as the first two right hand figures of the product; add 1 to the tens of the multiplier and multiply the tens of the multiplicand by it, and write the result on the left of the 25. Thus: $95\times95=9025$.

To multiply by 2 numbers together of 2 figures each, when the sum of their units equal 10, multiply the units, write the sum as the first right-hand figures of the product; increase the tens by 1, and multiply the tens of the multiplicand by it; write the product as the 2 last figures of the product required. Thus:

47	82	76	91	55	64
43	88	74	99	55	66
2021	7216	5624	9009	3025	4224

To Prove Multiplication by Unitation.

The unitate of a number is the sum of its digits reduced to a unit.

RULE.

Unitate the multiplicand, multiplier and product; multiply the units of the multiplicand and multiplier thus found, and unitate the product: unitate the product of the entire problem—if it is the same as that of the other 2 terms, the product is right, e. g.:

$$\left.\begin{matrix} 512=8 \\ 432=9 \end{matrix}\right\} =72=9$$

$$\begin{matrix} 1024 \\ 1536 \\ 2048 \end{matrix}$$

$$221184=18=9. \quad \text{Proof.}$$

Short Cuts in Division.

To divide by 10, 100, 1000, 10000, etc.

RULE.

Point off as many places in the dividend, beginning at the right, as there are ciphers in the divisor. Thus: $9235 \div 100 = 92.35$ or $92\frac{35}{100}$

When dividing by 200, 5000, etc., point off as above and divide by the digit, e. g.: $4846 \div 200 = 24.23$.

To divide by the aliquot parts of 100 or 1000.

RULE.

Multiply the dividend by the part the divisor is of 100 or 1000, and point off 2 places for the hundreds and 3 for the thousands, e. g.: $8000 \div 25 = 4 \times \frac{8000}{100} = 32.00$; $8000 \div 125 = 8 \times \frac{8000}{1000} = 64.000$.

To divide by 99, 999, 9999, etc.

RULE.

Subtract the dividend from a number 10000 greater than itself when dividing by 99, 999 or 9999, etc.; point off 2 places, beginning on the right; this will be the 2 right-hand figures of the quotient; the last left-hand figure of the dividend will be the next figure of the quotient. Point off as many places as 9's in the divisor.

1. e. g.: $23958 \div 99 = 30000 - 23958 = 6042$; 60.42 pointed off, 42 is the 2 right-hand figures of the dividend. Place 2, the first left-hand figure of the dividend, on the left of 42 and you have the quotient, 242.

2. e. g.: $4219578 \div 9999 = 5000000 - 4219578 = 422$, the quotient.

To divide by 101, 1001, etc., point off the 2 right-hand figures of the dividend if dividing by 101; if by 1001, point off 3; this will be the first two or three right-hand figures of the quotient; the first left-hand figure of the dividend will be the other figure of the quotient; place on the left. If the 2 right-hand figures are greater than 95, and if the first left-hand figure, beginning at the left of 5, is greater, subtract from the left hand figure of the dividend before placing it.

1. e. g.: $24442 \div 101 = 2$, placed before 42; thus 242 is the quotient

2. e. g.: $60095 \div 101 = 1$ from 6 placed before 95; thus 595 is the quotient.

To divide by 11 when the number is the multiple of 11.

RULE.

Write the first right-hand figure of the dividend as the first right-hand figure of the quotient; subtract this figure from the next to it, write it as the second figure; subtract this from the third figure and so on, bringing down the

result at each time. The last left-hand figure of the dividend will be the last left-hand figure of the quotent.

e. g.: 46552 ÷ 11=4232; write 2, 2 from 5 is 3; write 3 after 2; 3 from 5 leaves 2, write 2; 2 from 6 leaves 4, write 4; altogether=4232, the quotient.

To prove division by unitation.

RULE.

Unitate both terms, also remainder; multiply the unitate of the divisor by that of the quotient; unitate the products; subtract the unitate of the remainder from the sum of the digits of the dividend, unitate the difference. If this equals that of the quotient and divisor, the division is right, e. g.:

7=25)9498(379=19=10

75

199

175 30 7X10=70=7

248 5

225 25=7. Proof.

23=5

Short Cuts in Fractions, Decimals—Addition.

$423\frac{2}{3}$
$546\frac{3}{4}$
$970\frac{5}{12}$

Multiply the denominators; write 12 as the new denominator; multiply numerator 2 by the denominator 4; also the denominator 3 by the the numerator 3, add 8 and 9, which is 17, or 17-12, which equals 15-12; add 1 to the result and place 5-12. In subtraction proceed the same way, except subtract instead of adding.

To square a number ending in $\frac{1}{4}$, and $\frac{1}{2}$, and $\frac{1}{3}$.

RULE 1.

Square the number, add $\frac{1}{2}$ of the integer and 1-16.

e. g.: $24\frac{1}{4}X24\frac{1}{4}=24X24=576$; $576+12=588$: $588+\frac{1}{16}=588\frac{1}{16}$—Ans.

RULE 2.

Square the number and add the integer and $\frac{1}{4}$.

e. g.: $12\frac{1}{2}X12\frac{1}{2}=12X12=144$; $144+12\frac{1}{4}=156\frac{1}{4}$.—Ans.

RULE 2.

Square the number, add $\frac{2}{3}$ of it and 1-9 to the product.

e. g.: $12\frac{1}{3}X12\frac{1}{3}=144X\frac{2}{3}$ of $12X\frac{1}{9}=152\frac{1}{9}$—Ans.

Table of Decimals.

.25 =	$\frac{1}{4}$ of 100	.125 =	$\frac{1}{8}$ of 1000
.75 =	$\frac{3}{4}$ of 100	.875 =	$\frac{7}{8}$ of 1000
.$33\frac{1}{3}$ =	$\frac{1}{3}$ of 100	.$333\frac{1}{3}$ =	$\frac{1}{3}$ of 1000
.$66\frac{2}{3}$ =	$\frac{2}{3}$ of 100	.$666\frac{2}{3}$ =	$\frac{2}{3}$ of 1000
.$12\frac{1}{2}$ =	$\frac{1}{8}$ of 100	.$166\frac{2}{3}$ =	1-6 of 1000
.$37\frac{1}{4}$ =	$\frac{3}{8}$ of 100	.625 =	$\frac{5}{8}$ of 1000
.$16\frac{2}{3}$ =	1-6 of 100	.$833\frac{1}{3}$ =	5-6 of 1000
.$08\frac{1}{3}$ =	1-12 of 100	.375 =	3-8 of 1000

RULE.

To multiply any number by the above decimals, multiply the number by the equivalent fractions, and to divide by the same; multiply by the fraction inverted, and point off 2 places if hundredths and 3 if thousandths.

Compound Proportion.

RULE.

Arrange the terms in a statement according to the condition of the problem. Divide the product of the second and third terms by the production of the first.

e. g.; If 15 men, in 16 days of 9 hours each, can do a piece of work, how many men will be needed to do the same work in 8 days of 6 hours each?

STATEMENT.

Men.	Days.	Hours.
15	16	9
(x)	8	6

$$\left.\begin{matrix} 8:9 \\ 6:16 \end{matrix}\right\} :: 15 : ? = \frac{15X9X16}{8X6} = 45 \text{ Men.}$$

Short Cut in Interest.

To find the interest when months and days are given.

RULE.

Place the principle, the time in days and the rate per cent. reduced to thousandths above a horizontal line and 2, 3 and 6 the factors of 360 below it—cancel and point off three places.

e g.: Willie Smith borrowed $600 for 6 months at 6%, how much interest did he pay?

STATEMENT.

$$\frac{600 \times .006 \times 180}{2 \times 3 \times 6} = \$18.$$

Bank Discount.

RULE.

Add three days of grace to the time and solve by interest rule.

e. g.: What is the bank discount on $120 at 8 % for 21 days?

STATEMENT.

$$\frac{120 \times .008 \times 24}{2 \times 3 \times 6} = \$.64 \quad \text{Int.}$$

Commercial Discount.

RULE.

Subtract each discount from 100 and multiply the differences together, point off as many decimal places in the product as there are ciphers in the 100's used, and multiply this result by the list price.

e. g.: A bought a piano at C. F. Brown's listed at $950, discount 45 % and 5 % for cash, what was the price?

STATEMENT.

$$\begin{array}{ccccc} 100 & & 100 & & \\ \underline{45} & & \underline{5} & & \\ 55 & \times & 95 & = \$5225 \times \$950 = & \$496.37\frac{1}{2}. \end{array}$$

To Mark Goods at Any Rate.

RULE.

Place the cost and 100 plus the rate above the line and 100 below, point off.

e. g.: C. W. Halbruge bought goods at 40 cents per yard, what should be his mark price so as to gain 25%.

STATEMENT.

$$\frac{40 \times 140}{100} = 56 \text{ Cents.}$$

Lumber Measure.

RULE.

Place the number of pieces, their length, width and thickness above the line, and 3 and 4 below. Cancel.

e. g.: How many feet of lumber in 90 planks 12 feet long and 8 inches wide?

STATEMENT.

$$\frac{90 \times 12 \times 8}{5 \times 4} = 720 \text{ Feet.}$$

To find the amount of square-edge inch boards that can be sawed from a round log.

RULE.

Place two 4's below the line, from the diameter in inches, subtract 4, put the remainder down twice above the line with the length. Cancel.

e. g.: How much square-edge inch lumber can be cut from a log 44 inches in diameter and 30 feet long?

STATEMENT.

$$\frac{40 \times 40 \times 30}{4 \times 4} = 3000 \text{ Feet.}$$

To find the number of planks in a floor.

RULE.

Place the dimensions of the house-floor and 12 above the line and the length and width of a plank below.

e. g.: How many planks 10 feet long and 6 inches wide will floor a room 30 feet long and 24 feet wide?

STATEMENT.

$$\frac{30X24X12}{10X6}=144 \text{ Planks.}$$

To find the length of rafters.

RULE.

Place the width of the house and 7 above the line and 12 below.

e. g.: What will be the length of a rafter for a house 48 feet wide?

STATEMENT.

$$\frac{48X7}{12}=28 \text{ Feet.}$$

To find the number of shingles.

RULE.

Place the length of the plate, twice the length of the rafter and two 12's above the line and the width of a shingle and as much of its length as you let show, below the line.

e. g.: How many shingles will it take to cover a house, the plate 40 feet long, the rafters 10 feet and shingles 6 inches wide, 4 to the weather.

STATEMENT.

$$\frac{40X20X12X12}{6X4}=4800 \text{ Shingles.}$$

Grain Measure.

SQUARE CRIB.—RULE.

Place 5, 10 and 43, factors of 2150.4 cubic inches below the line and the length, width and height in inches above. Cancel.

e. g.: How many bu. of shell corn will a crib hold that is 240 inches long, 225 inches wide and 129 inches high?

STATEMENT.

$$\frac{240X225X129}{5X10X43}=3540 \text{ Bu.}$$

ROUND CRIB.—RULE.

Place the diameter twice and the height in inches and .187 above the line and 4, 8 and 16 the factors of 512 below. Cancel. $\frac{.7854}{2150.4}=\frac{.187}{512}$ reduced.

e. g.: How many bushels will a round crib hold of shelled corn if it is 128 inches in diameter and 80 inches high?

STATEMENT.

$$\frac{128\text{X}128\text{X}.187\text{X}80}{4\text{X}8\text{X}16}=478.72 \text{ Bu.}$$

To find the number of bu. of shuck corn in a crib, bin or wagon.

RULE.

Multiply the dimensions by .8 and divide by 2, or place 2, 10 below the line and the length, breadth and height and 8 above.

e. g.: How many bu. of corn on the cob in a pen 12 ft. wide, 10 ft. high and 16 ft. long?

STATEMENT.

$$\frac{12\text{X}10\text{X}16\text{X}8}{2\text{X}10}=768 \text{ Bu.}$$

Corn in the Grain.

RULE.

Place 10 below the line and dimensions and 8 above.

e. g.: George Bright's wagon-bed is 12 ft. long, 4 ft. wide and 2 ft. deep; it holds how many bu. of shell corn?

STATEMENT.

$$\frac{12\text{X}4\text{X}8}{10}=38.4 \text{ Bu.}$$

Corn in the Shuck.

RULE.

Place 10 and 3 below the line and the dimensions, and 8 and 2 above.

e. g.: How many bu. of unshucked corn will a wagon bed 12 ft. long, 4 ft. wide and 2 ft. deep, hold?

STATEMENT.

$$\frac{12X4X2X8}{10X3}=25.6 \text{ Bu.}$$

Hay Measure.

To find the quantiry of hay in a stack rick or mow.

RULE.

Divide the cubical contents in ft. by 550 for clover or place 11, 5 and 10 below the line and the dimensions above. Cancel. For timothy divide by 450 or place 5, 9 and 10 below the line and the dimensions below it.

e. g.; How many tons of hay, timothy, in a square hay mow 20 ft. long, 18 ft. wide and 10 ft. high?

STATEMENT.

$$\frac{20X18X10}{5X9X10}=8 \text{ Tons.}$$

NOTE—If in shape of a pyramid or cone, find the cubical contents and multiply the base by $\frac{1}{3}$ of the altitude.

To measure cord-wood:

RULE.—Place the dimensions in feet above the line and 4, 8 and 4, the factors of 128 cubic ft. below.

e. g.: How many cords of wood in a pile 64 ft. long, 8 ft. wide and 16 ft. high?

STATEMENT.

$$\frac{64X8X16}{4X4X8}=64 \text{ Cords.}$$

Perch Measure.

RULE.—Place the dimensions in ft. and 4 above the line and 3, 11 and 3 below, the factors of $24\frac{3}{4}$ or $\frac{99}{4}$ cubic ft. in a perch.

e. g.: How many perches of stone in a wall 66 ft. long, 18 ft. high and 3 ft thick?

STATEMENT.

$$\frac{66\times18\times3\times4}{3\times3\times11}=144 \text{ Perches.}$$

To measure land.

RULE.—Place the dimensions in rods above the line and 10, 4 and 4, the factors of 160 rods, below.

e. g.: How many acres in a field of 240 rods long and 160 rods wide?

STATEMENT.

$$\frac{240\times160}{4\times4\times10}=240 \text{ Acres.}$$

To find either side of a field.

RULE.—Place 4, 10 and 4, the factors of 160, and the length of the given side in rods above the line and the number of acres required below.

e. g.: Dennie Mahones measured 80 rods on one side of a field that he wants to contain 80 acres, how many rods must he measure on the other side to enclose the field?

STATEMENT.

$$\frac{160\times80}{80}=60 \text{ Rods.}$$

To measure a square cistern:

RULE—Place the factors of 231 cubic in., 3, 7 and 11, below the line and the dimensions in inches above.

e. g.: How many gallons will a cistern hold that is 88 in. long, 33 in. wide and 63 in. deep?

STATEMENT.

$$\frac{88\times63\times33}{3\times7\times11}=792 \text{ Gallons.}$$

To find the dimensions of a square cistern:

RULE—Place 3, 7 and 11 and the given number of gallons above the line and the given dimensions below.

e. g.: How deep must a cistern be to hold 792 gallons of water, if the length is 88 inches and width 63 inches?

STATEMENT:

$$\frac{3\times7\times11\times792}{88\times63}=33 \text{ Inches.}$$

To find the contents of a cistern or a vessel in shape of cylinder, cone or frunstum of a cone:

RULE.—Place the diameter twice, the depth in inches and 34 above the line and 10 four times below. Thus multiplying the cubical contents by .0034.

e. g.: How many gallons in a round cistern 240 inches in diameter and 1600 inches deep?

STATEMENT.

$$\frac{240\times240\times1600\times34}{10\times10\times10}=313344 \text{ Gallons.}$$

To find the number of bricks in a wall:

RULE.—The dimensions of a brick is 2, 4 and 8 inches; place below the line and the dimensions of the wall in inches above.

e. g.: If a wall is 240 inches long, 192 Inches high and 32 inches thick, how many bricks required to build it?

STATEMENT.

$$\frac{240\times32\times192}{2\times4\times8}=23040 \text{ Bricks.}$$

Short Cuts in Mensuration.

To find the circumference:

RULE.—Place 7 below the line and 22 and the diameter above. Remember — —— 3.1416 or 3 1-7 nearly.

e. g.: What is the circumference of a wheel whose diameter is 21 inches?

STATEMENT.

$$\frac{21\times22}{7}=66 \text{ Inches.}$$

To find the diameter when circumference is given:

RULE.—Place 2 and 11 below and 7 and the circumference above

e. g.: What is the diameter of Herman's hoop whose diameter is 66 in.?

STATEMENT.

$$\frac{66 \times 7}{2 \times 11} = 21 \text{ Inches.}$$

To find the area of a circle:

RULE.—Place 4 below the line and the diameter and the circumference above, when circumference is given. Cancel.

e. g.: What is the area of a circle whose diameter and circumference are 14 and 24 inches respectively?

STATEMENT.

$$\frac{24 \times 14}{4} = 84 \text{ Sq. In.}$$

To find the area of a circle when the diameter is given:

RULE.—Square the diameter and multiply by .7854 or $\frac{1}{2}$ of 3 1-7 or $\frac{22}{28}$. Place 22 and the diameter twice above the line and 7 and 4 below. Cancel.

e. g. Find the area of a circle whose diameter is 56 inches.

STATEMENT.

$$\frac{56 \times 56 \times 22}{4 \times 7} = \text{Sq. In.}$$

Find the area when the radius is given:

RULE.—Square the radius and multiply by 3.1416 or 3 1-7, or place 22 and the radius twice above the line and 7 below.

e. g.: Find the area of a circle whose radius is 28 inches.

STATEMENT.

$$\frac{28 \times 28 \times 22}{7} = 2464 \text{ Sq. In.}$$

To find the diameter when the area is given:

RULE.—Extract the square root of the area and multiply the root by 1.1284

What is the diameter of a circle if the area is 625 sq. in.?

STATEMENT.— $\sqrt{625} = 25$; $25 \times 1.1284 = 2821$ inches, diameter.

To find one side of an inscribed equilateral triangle:

RULE.—Multiply the diameter by 86.

e. g.: The diameter of an inscribed equilateral triangle is 50 inches, what is one side?

STATEMENT.—.86X50=43.00 inches.

To find the side of an inscribed square:

RULE.—Multiply the diameter by .7071 or the circumference by .225.

e. g.: What is one side of an inscribed square whose circumference is 60 inches?

STATEMENT.—.225X60=13.500 inches.

To find the area of a circumscribed square:

RULE.—Square the diameter.

e, g.: What is the area of a circumscribed square whose diameter is 40 inches?

STATEMENT: 40X40=1600 sq. in.

To find the side of a square equivalent to a given circle :

RULE.—Multiply the diameter by .8862, or the circumference by .282.

e. g.: What is the side of a square equivalent to a given circle whose diameter is 10 inches?

STATEMENT: 10X.88620 inches.

To find the area of an ellipse :

RULE.—Multiply the product of ½ the two axes by 3.1416 or 3⅐, or multiply the product of the two axes by $\frac{22}{28}$ or .7854.

e. g.: What is the area of an ellipse whose axes are 30 and 20 inches respectively?

STATEMENT: 30X20X.7854=471.2400 area.

To find the area of a sector of a circle:

RULE.—Multiply the arc of the sector by ½ the radius; next find area of the circle, then 360° arc : of sector : : area of circle : area of sector.

To find area of segment of a circle:

RULE.—Find area of sector having same arc, area of the triangle found by the arc of segment and the two radii; subtract the area of triangle from area of sector. The remainder is the area of the segment if it be less than a semi-circle; or add the area of the triangle to that of the sector if the segment is greater than a semicircle.

To find the area of a circular ring:

RULE.—Square the radius of the larger and smaller circumference and multiply their difference of squares by 3.1416. or 3 1-7.

General Rules.

To find the convex surface of a prism or cylinder: RULE.—Multiply the perimeter of the base by the altitude.

To find the volume of a prism or cylinder: RULE.—Muitiply the area of the base by the altitude.

e. g.: What is the volume of a cylinder whose altitude is 10 ft. and base diameter 5 ft.?

STATEMENT: $5^{2}X\frac{2}{2}\frac{2}{8}X10=196$ 3-7 sq. ft.

To find the convex surface of a cone or a pyamid: RULE.—Multiply the perimeter or circumference of the base by ½ the slant height.

To find the volume of a pyramid or a cone: RULE.—Multiply the area of the base by ⅓ of the altitude.

To find the convex surface of a frustum of a cone or pyramid: RULE.—Multiply the sum of the perimeters or circumferences of the bases by ½ the slant height.

To find the volume of a frustum of a pyramid or cone: RULE.—To the sum of the areas of both bases add the square root of the product, and multiply this sum by ⅓ of the altitude.

To find the surface of a sphere: RULE.—Multiply the diameter by the circumference of a great circle of the sphere.

To find the volume of a sphere: RULE.—Multiply the surface by $\frac{1}{6}$ of the diameter, or ⅓ of the radius or multiply the cube of the diameter by $\frac{1}{6}$ of 3.1416 or 3 1-7.

To find the convex surface when the radius, diameter or circumference are only given: RULE.—Radius, $^{2}X12.5664$; diameter, $^{2}X3.1416$; circumference, $^{2}X3183$.

To find the volume of a sphere when surface, radius, diameter and circumference are only given. RULE.—Surfnce $X\frac{1}{6}$, its diameter. Radius, X4.1888; diameter, $^{3}X5236$; circumference, $^{3}X0169$.

To find the diameter of a sphere when the surface and volume are given: RULE.—$\sqrt{\text{Surface}}$, X5642; $\sqrt{\text{Of volume}}$, 91.2407.

To find circumference when surface or volume is given: RULE.—$\sqrt{\text{Of surface}}$, X1.7725; $\sqrt[3]{\text{Of volume}}$, X3.8978.

To find radius of a sphere when surface or volume is given: RULE.—$\sqrt{\text{Of surface}}$, X .2821; $\sqrt[3]{\text{Of volume}}$, X .6204.

To find the side of an inscribe cube when radius or diameter is given: RULE.—Radius, X1.1547; diameter, X.5774.

GAUGING.

To find the volume of a cask in gallons: RULE.—Multiply the square of the mean diameter by the length, in inches, and this product by .0034.

e. g.: How many gallons in a cask whose head diameter is 24 inches, bung diameter 30 inches, and length 34 inches?

STATEMENT: $24X\ (30\text{-}24X\frac{2}{3}=28$ in mean diameter; $28^2X34X.0034=90.63$ gallons.

To find the mean diameter if the staves are slightly curved add $\frac{6}{10}$ of the difference of the head and bung diameters to the head diameter; but if the staves are straight from the bung, add $\frac{2}{3}$; expressed in inches, square it, multiply it by the length in inches, and this product by .0034.

To find the area of a regular polygon. RULE.—Multiply the perimeter by $\frac{1}{2}$ the apothem. NOTE.—The apothem is the common altitude of an isosceles triangle of a regular polygon, and the perimeter is the sum of their bases.

To find the area of a triangle. RULE—Take half the product of the base by the altitude.

To find the area of a triangle when the sides are given. RULE—Add the three sides together and take half the sum; from the half sum take the sides separately; multiply the half sum and the three remainders together, and extract the square root of the product.

To find the area of a trapezoid. RULE—Multiply half the parallel sides by the altitude.

To find the hypothenuse when two sides are given. RULE—Add together the squares of the base and perpendicular, and extract the square root of the sum.

To find one side when the hypothenuse and one side are given. RULE—Subtract the square of the given side from the square of the hypothenuse, and extract the square root of the difference; or multiply the square root of the sum of the hypothenuse and side by the square root of their difference.

To square a number of two figures ending in 5. RULE—Write 25 as the first two figures of the product; add 1 ten to the multiplier's tens and multiply the tens of the multiplicand by it and write the result on the left of 25. e. g: $85^2=5X5=25$; $1+8X8=72$; 72 placed before 25=7225 the square.

To find the square of a number of three figures ending in 25. RULE—Write the square of 25 or 625 as the figures of the square; square the hundreds, add half the hundreds as ten thousands, and write the result on the left of 0625.

e. g: 225^2 = 225 / 225 / 50625=the square.

To square a number ending in 75. RULE—Square the hundreds, add $\frac{3}{2}$ of the hundreds as ten thousands, add 5625.

e. g: 875^2 = 875 / 875 / 765625 = the square.

To square a number ending in $\frac{1}{3}$. RULE—To the square of the number add $\frac{2}{3}$ of it and $\frac{1}{9}$. e. g:

$24\frac{1}{3}X24\frac{1}{3}=24X24=575$; $576+\frac{2}{3}$ of $24+\frac{1}{9}=592\frac{1}{9}$.

To square a number ending in $\frac{1}{2}$. RULE—To the square of the number add it and $\frac{1}{4}$. e.g.

$24\frac{1}{2}^2=24X24+24+\frac{1}{4}=600\frac{1}{4}$ sq.

To square a number ending in $\frac{1}{4}$. RULE—To the square of the number add $\frac{1}{2}$ of it and $\frac{1}{16}$. e.g.

$12\frac{1}{4}^2 = 12 \times 12 = 144$; $144 + 12 + \frac{1}{16} = 150\frac{1}{16}$ the square.

To square a number ending in $\frac{3}{4}$. RULE—To the square of the number add $\frac{3}{2}$ of it and $\frac{9}{16}$. e. g.

$16\frac{3}{4}^2 = 16 \times 16 = 256$; $256 + \frac{3}{2}$ of $16 + \frac{9}{16} = 280\frac{9}{16}$,

To square a number ending in $\frac{2}{3}$. RULE—To the square of the number add $\frac{4}{3}$ of it and $\frac{4}{9}$. e. g.

$12\frac{2}{3}^2 = 12 \times 12 = 144$; $144 + \frac{4}{3}$ of $12 + \frac{4}{9} = 150\frac{4}{9}$.

To extract the square root of a number of four figures ending in 5. RULE—Extract the nearest square root in the hundreds and place it as the tens of the root and 5 as units. e. g. $\sqrt{5625} = 75$; for 7 is the nearest square root in 56. Thus 75 is the square root.

To extract the square root of a number consisting of five or more figures ending in 5. RULE — Extract the square root of the hundreds as above and place before it, in hundreds place, the nearest square root of the fifth figures or of ten thousands. e. g.

$\sqrt{75625} = 275$; 75 is the square root of 5625 and 2 is the square root of 7 nearly.

To extract the square root of a number ending in 9—an exact square. RULE—Extract the square root of the hundreds; substract this square from the hundreds and divide the difference by twice root found; if this equals 3, the unit root is 3; if not, it is 7. e.g.

$\sqrt{6889} = 823$ square root. Nearest square root in 68 is 8; 68—64=4, or 48 considered; 2X8=16. 48 ÷ 16 = 3. the unit figure of the root. e. g.

$\sqrt{4489} = 67$; 6 is the nearest square root in 44; 44—36=8; or 88; 2X6=12; 88 ÷ 12 don't=3, therefore 7 is the unit figure of the root.

To extract the fourth root of an exact number. RULE—Extract the square root, then extract the square root of it; this will be the 4th root. e. g.

$\sqrt{20736} = 144$; $\sqrt{144} = 12 = 4$th root.

To extract the 6th root of an exact number. RULE—Extract the cube root; then extract the square root of this; the square root found will be the 6th root. e. g.

$^{6}\sqrt{2985984} = 12$. Sixth root

Proof.		2985984 (144
		1
1^2 X300=	300	1985
1X4X 30=	120	$\sqrt{144} = 12$=6th root.
4^2=	16	
	436	1744
		241984
14^2X 300=	58800	
14X4X 30=	1680	
42=	16	
	60496	241984

Finding the age of a person who is reluctant in giving it. RULE.—Tell them to double the number of the month in which they were born, add 5 to it; then to multiply it by 50; add the age; substract 365, add 115; then ask for the amount. The two figures to the right will denote the age, and the remainder the month of birth.

e. g.: Harold was born in the fifth month and age 16, find his age by rule above.

STATEMENT: 2X5=10+5=15; 15-X50=750+16=766; 766—365=401; 401X115=516; 5 is the number of the month in which he was born, and 16 his age.

Weighing the brain or amusement in numbers.

By the following rule you can tell what is the first number the counter takes without being told.

RULE.—Tell the counter to take a number; double it; to add a number to it; half it and give you the half and ½ of the number added.

To find the counter's first number double both numbers given to you, subtract the less from the greater and divide the difference by 2; the quotient will be his first number.

e. g.: Suppose counter takes 2, doubles it, which is 4,

adds 10 to it, which is 14; gives you one-half, which is 7, and 5 one-half of the number added.

To find his number, you would double 7, which is 14, also 5, which is 10; 10 from 14 leaves 4; ½ of 4=2 his first number.

You may call his first number the weight of his brain. Much pleasure can be had through this mental work. Try it. Say take a number, double it, add a number to it; half it; give me the half; also the half of the number added. You do the rest.

REMEMBER TO PUSH A GOOD THING ALONG.

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SHORT CUTS.

Ef you think about it keerfully
An' put it to de tes',
You'l diskivir dat de Short Cuts
Am gin'ully de bes'.

Whether figurin' at de counter,
Or fleein' from the law,
Or strikin' at de hornet
Dat's lit upon de jaw.

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